VAMS Technical Interchange Meeting #4 – Feb. 10-12, 2004

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Wake Vortex Avoidance System (WakeVAS) Concept of Operations & Self-evaluation

February 10-12, 2004

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Self-evaluation and Procedures Development

AirSC

- Develop initial conops
- Develop parametric model of CONOPS that can be integrated with self-evaluation tools that captures operational and climatic traits specific to each airport in the analysis

ASCAC

- AVOSS-based time and distance flows as inputs to airport simulation
- 13 WakeVAS airports with specific configurations
- Calculate Δ arrival/departure between current MIT standards and potential separations at WakeVAS airports
- Calculate NAS throughput and traffic flow impacts based on future demand forecast

AirSC

- Refine conops based on traffic flow analysis
- Develop pilot and/or ATC procedures based on traffic flow analysis and updated/new experiment data

WakeVAS Self-evaluation Tools

- Wx, physics, aircraft flow data collection and correlation
    - WakeVAS Parametric Behavioral Model developed from AVOSS project products
- Experiment plan development
    - RAMS Plus simulation
- WakeVAS traffic flow effect analysis
    - RAMS Plus simulation
    - Data Analysis Tools
    - AwSIM/Draper Laboratory simulation
    - ACES when available

Configuration and System Parameters

- Airport configurations
  - **ATL, BOS, CLT, DFW, EWR, JFK, LAX, LGA, MEM, MIA, ORD, SFO, STL**
  - DTW will be added as a replacement for MEM
- Airport/Airspace operations
- Environmental Conditions
- Aircraft type and operations
- NAS operations
- WakeVAS systems

Traffic Flow Simulation
Key Input Variables

- Vehicle separations = f(t) or f(d)
  - Affect local/airport capacity increases
- Prediction accuracy = f(t) (future, <u>x</u> hour to start)
  - Affects NAS capacity increases
- Off-nominal events & recovery mechanisms
- Future traffic demand

Metrics & Output Dataset

- Expected Outcome
  - Increased arrival/departures rates at flow-constrained airports
  - Faster, more effective recovery abilities
  - Increased NAS-level efficiencies
- Output Dataset
  - Localized NAS throughput
  - Airport arrival/departure rates
  - Fix metering/gate crossing
  - Spacing and speed margins

Experiment Plan

Develop total NAS ATM system in RAMS Plus, AwSim and FACET including airports, navaids, route structures, ATSP entities, etc. [Completed]

Format traffic schedule and demand data from ACES Traffic Demand Schedule – Apply demographic/economic-driven growth rates across schedule for future growth. [Completed]

Obtain weather event, dynamic spacing results and predictive values from AVOSS Simulation experiments correlated with true historical weather data. [LaRC AirSC - Completed]

Perform series of simulation runs of each demand schedule using current configurations, airspace use and ATM procedures to establish a multi-level baseline datasets – validate same using existing research data and operational information. [95% Completed]

Perform series of simulation scenarios incorporating the AVOSS concept and simulation – goal is production of multiple broad-ranged output datasets for in-depth analyses of the impacts and effects to the NAS. [95% Completed]

Analyze and evaluate output data to measure effects and assess apparent effects within the NAS at a local, regional and national level – report results via established metrics and further correlation of potential effects not otherwise realized. [50% Completed]

Establish a basis from which a quantifiable value of AVOSS implementation and subsequent ATM policy/procedural changes could be effected.

WakeVAS Parametric Model Development

- Concept model compatible with higher level simulations was required
- AVOSS batch-mode DFW simulation adapted for general airport use
- Input terminal weather sets synthesized for AVOSS simulation

Meteorological Profile Generation

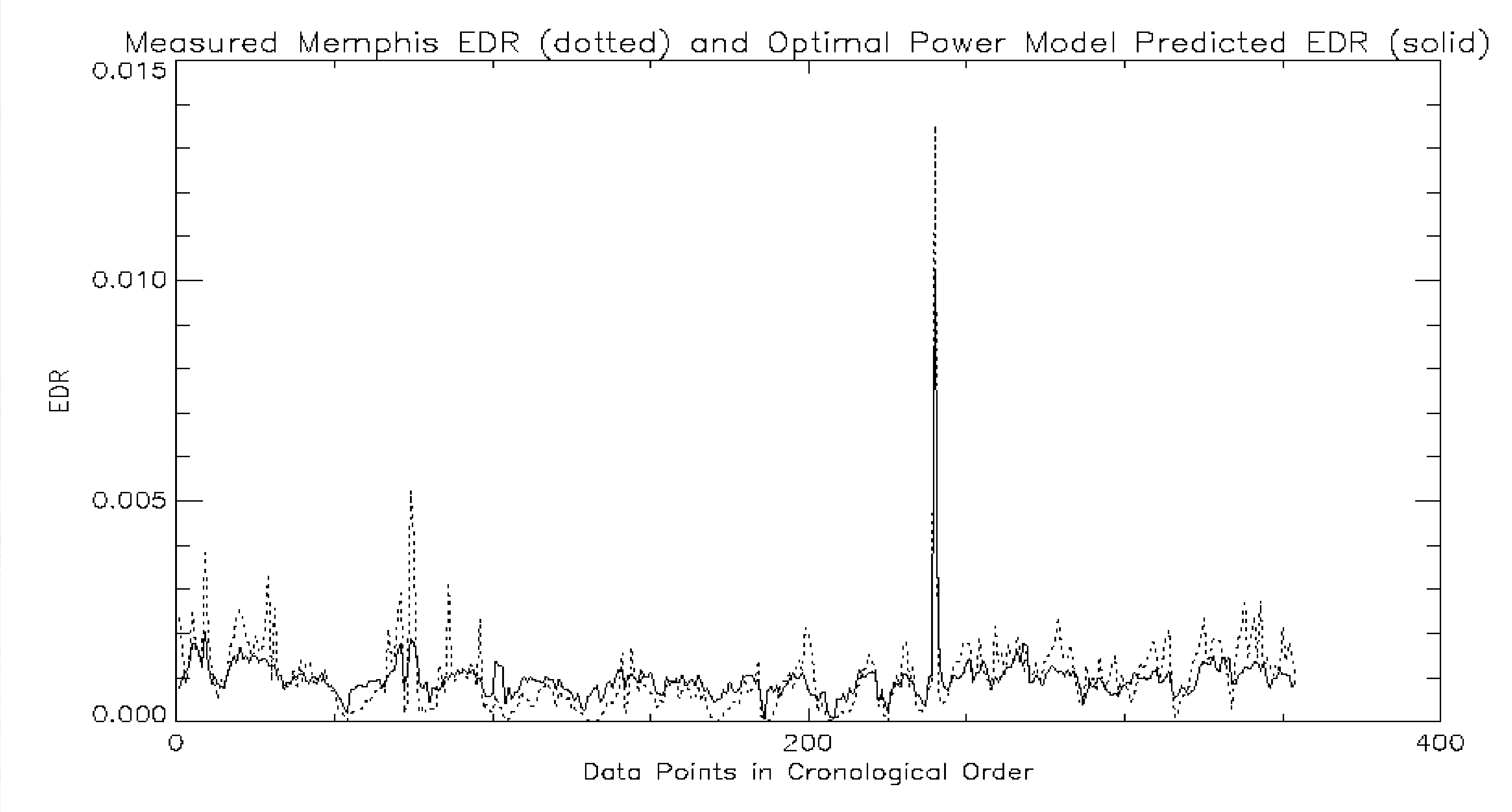
- Extensive high-resolution data collected during the AVOSS project in MEM and DFW used
- DFW data used to develop a multivariable linear regression model for atmospheric turbulence, that accepts typical surface weather data archived by the National Climatic Data Center (NCDC)
- Model validated against MEM turbulence data
- Allows for estimation of high-resolution weather parameters necessary for wake simulation at locations and times where field data was not collected

EDR Regression Model Variables

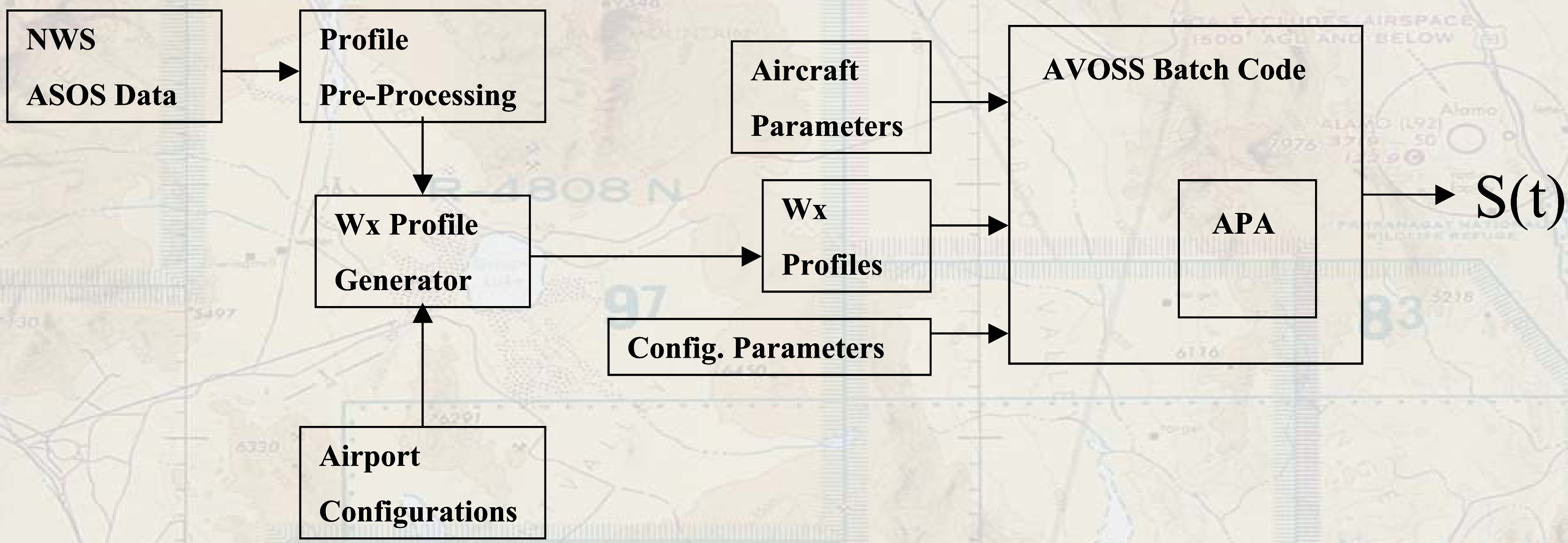
	Measurement Period	Used for EDR Estimates
Wind Speed	2 minutes	yes
Wind Gust	max. 5 second for each minute	no
Wind Direction	2 minutes	yes
Variable Wind Direction	max. 5 second for each minute	no
Temperature	1 minute	yes
Dew Point	1 minute	yes
Altimeter Setting	1 minute	no
Precipitation	1 minute	no
Day/Night	1 minute	yes
Visibility	1 minute	no
Precipitation Discrimination	1 minute	no
Lightning Discrimination	1 minute	no

Memphis Day EDR Prediction by DFW

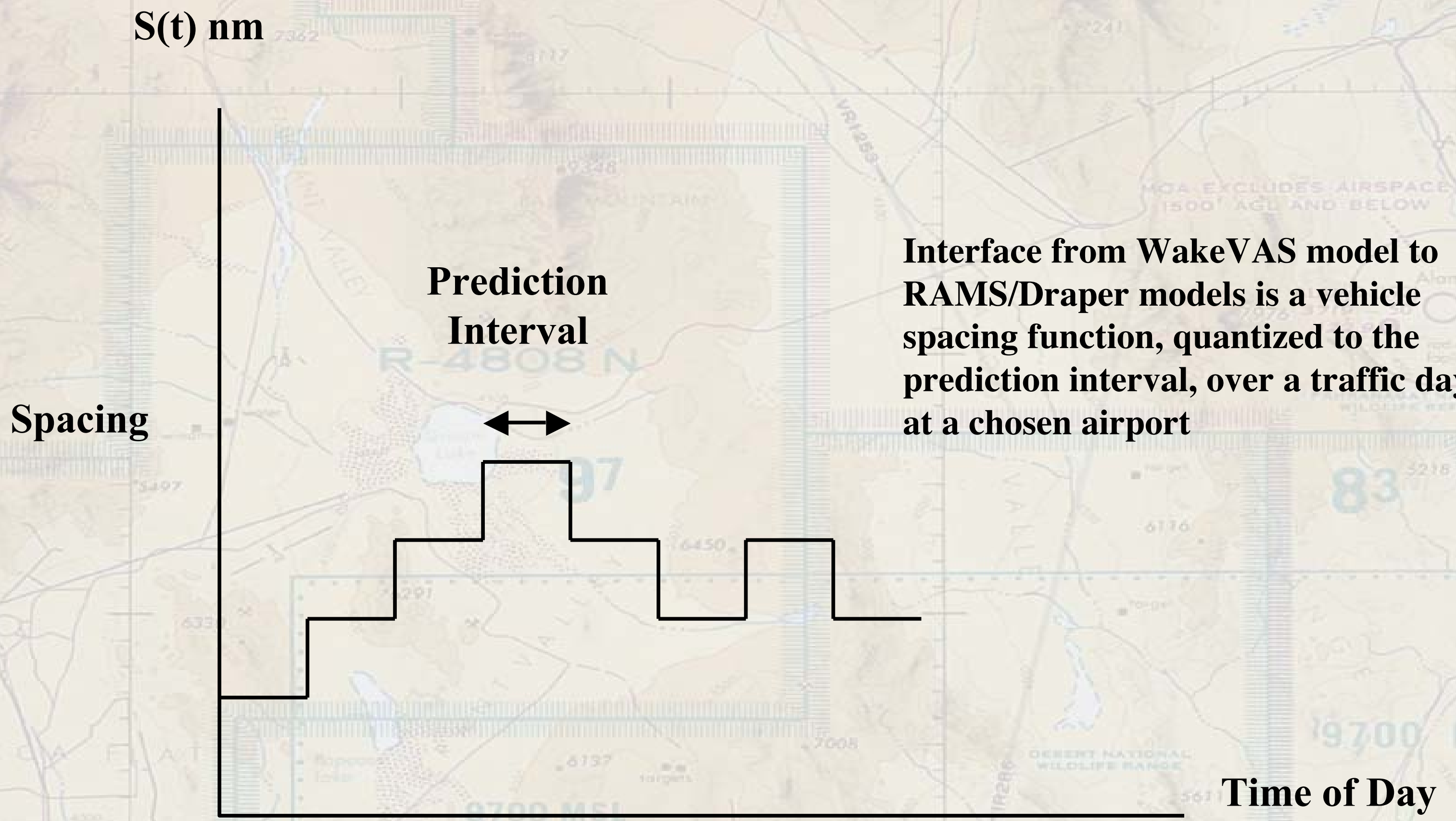
Fit 6-IV Day Model



WakeVAS Parametric Behavioral Model

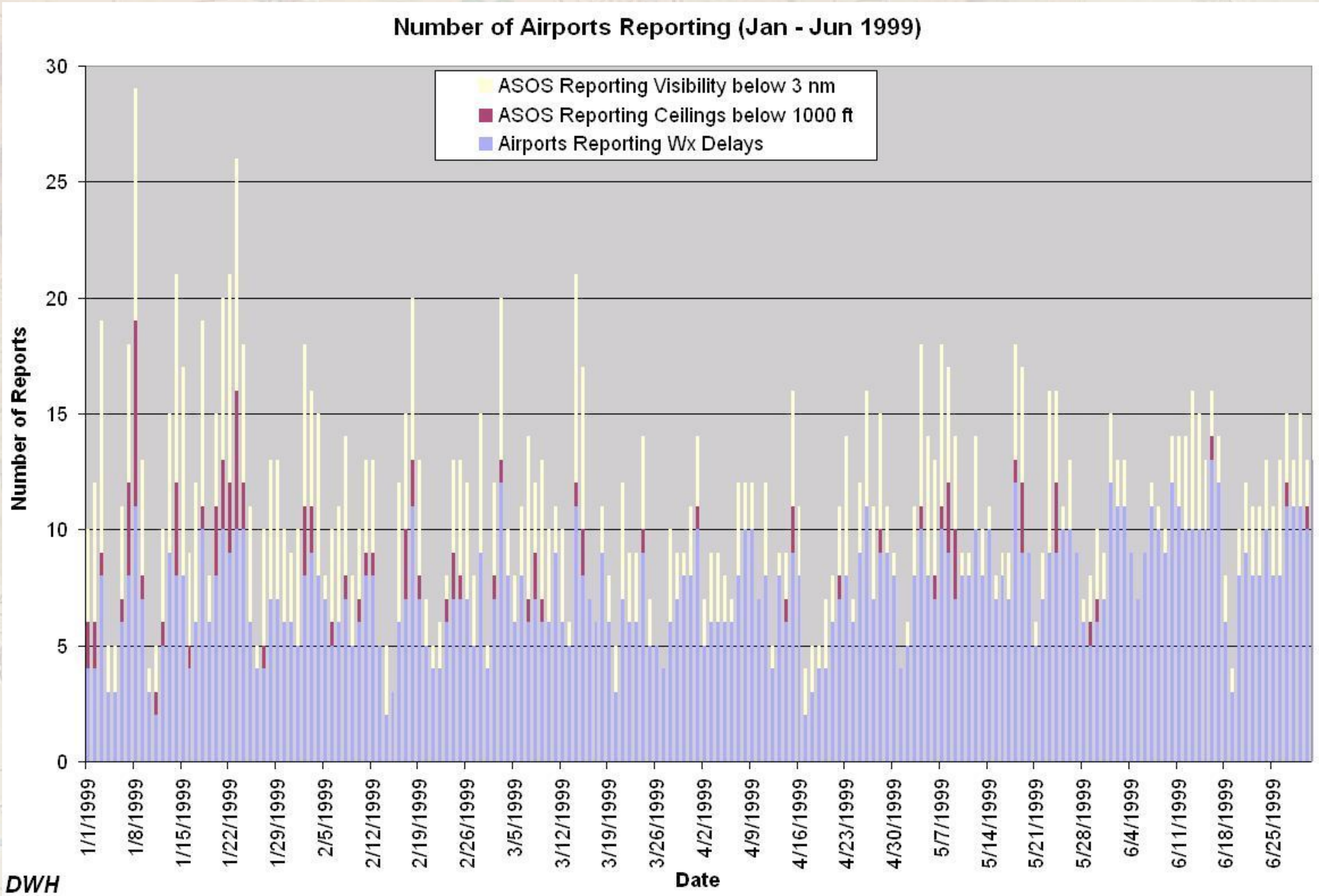


WakeVAS Parametric Behavioral Model Output



Interface from WakeVAS model to RAMS/Draper models is a vehicle spacing function, quantized to the prediction interval, over a traffic day at a chosen airport

Choice of Weather Days

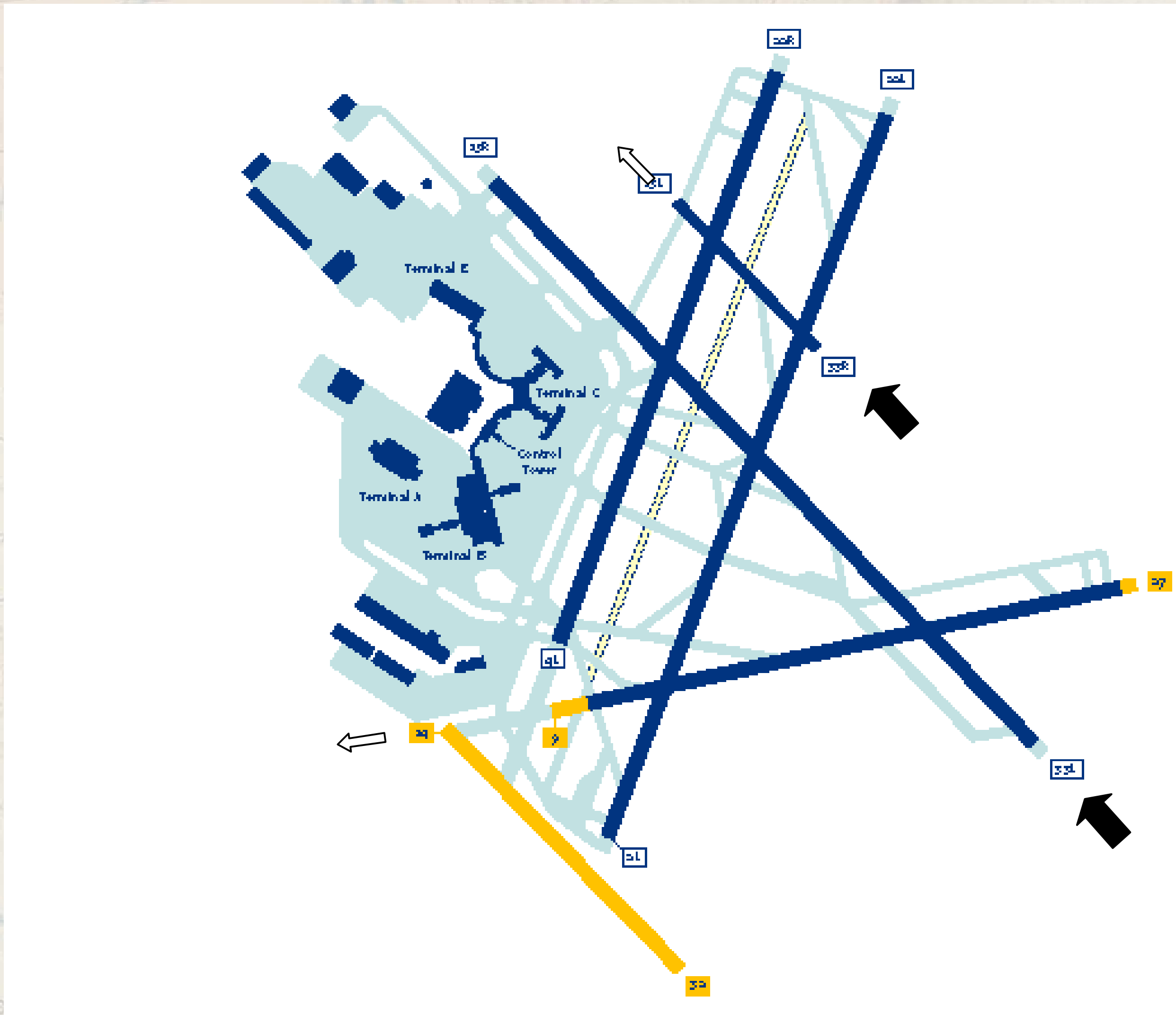


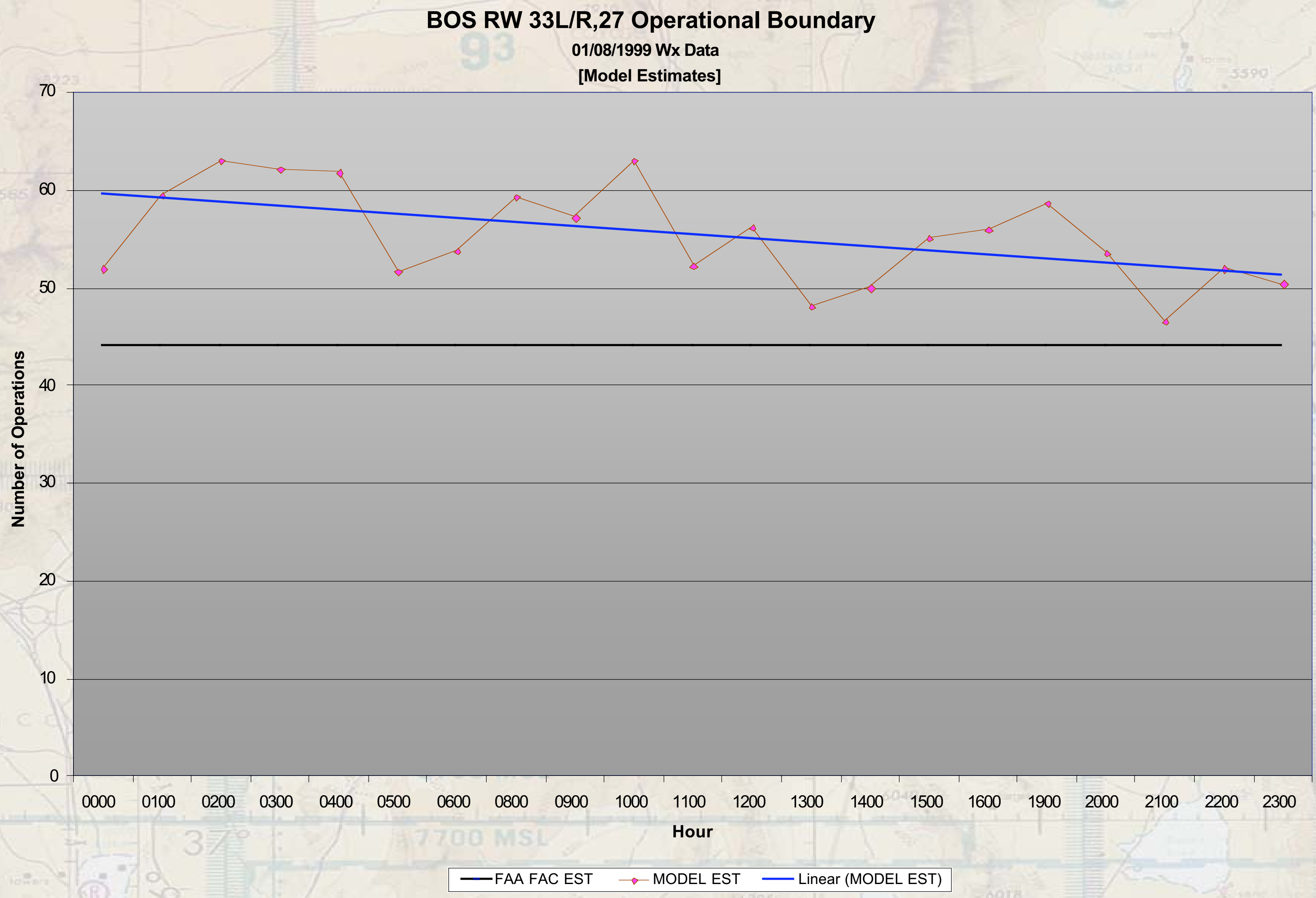
Analysis Results

BOS

EWR

BOS




BOS RW 33L/R,27 Operational Boundary
01/08/1999 Wx Data
[Model Estimates]
Number of Operations
Hour
0
10
20
30
40
50
60
70
0000
0100
0200
0300
0400
0500
0600
0800
0900
1000
1100
1200
1300
1400
1500
1600
1900
2000
2100
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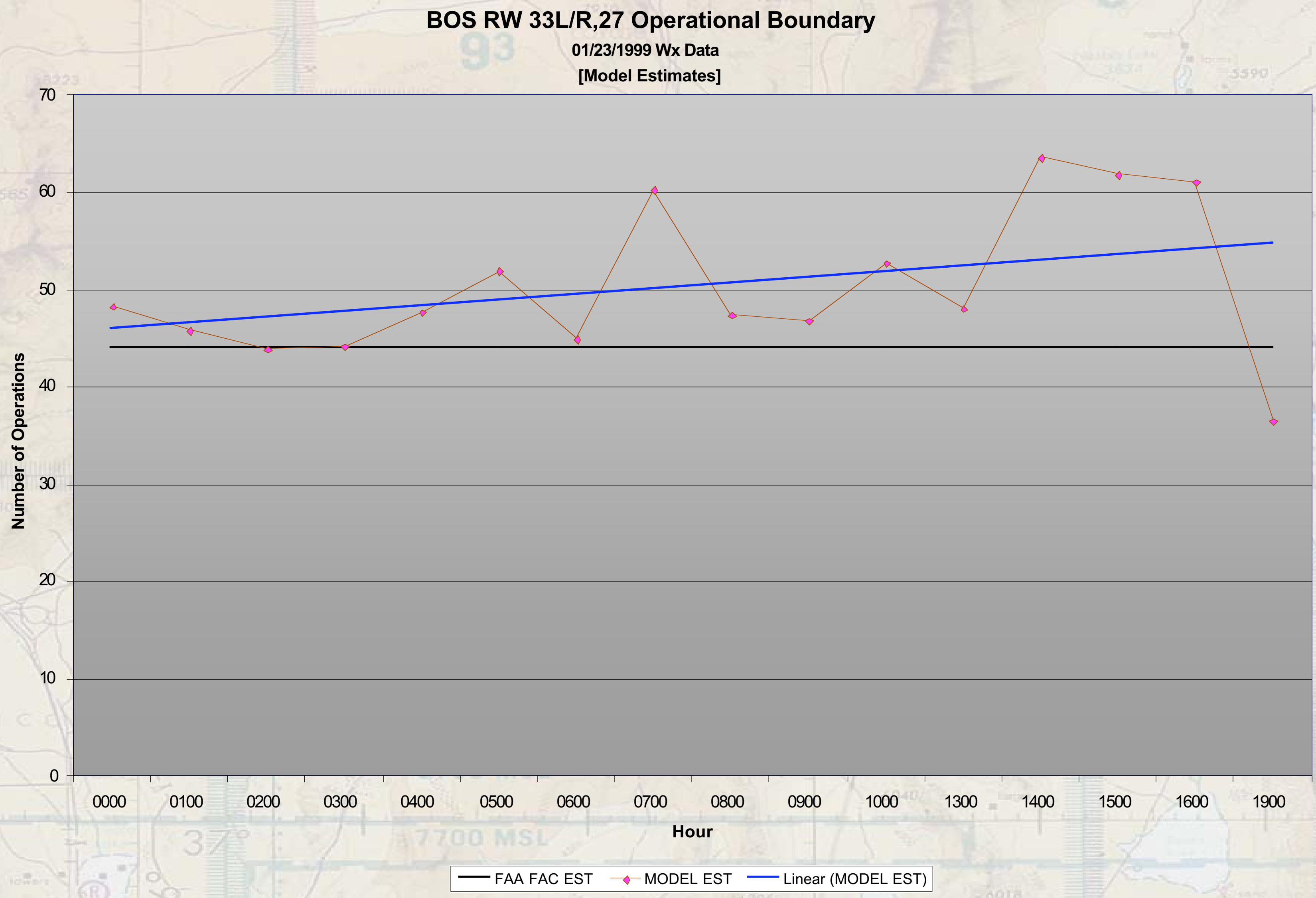
FAA FAC EST
MODEL EST
Linear (MODEL EST)


BOS RW 33L/R,27 Operational Boundary
01/23/1999 Wx Data
[Model Estimates]
Number of Operations
70
60
50
40
30
20
10
0
0000
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
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Hour
FAA FAC EST
MODEL EST
Linear (MODEL EST)

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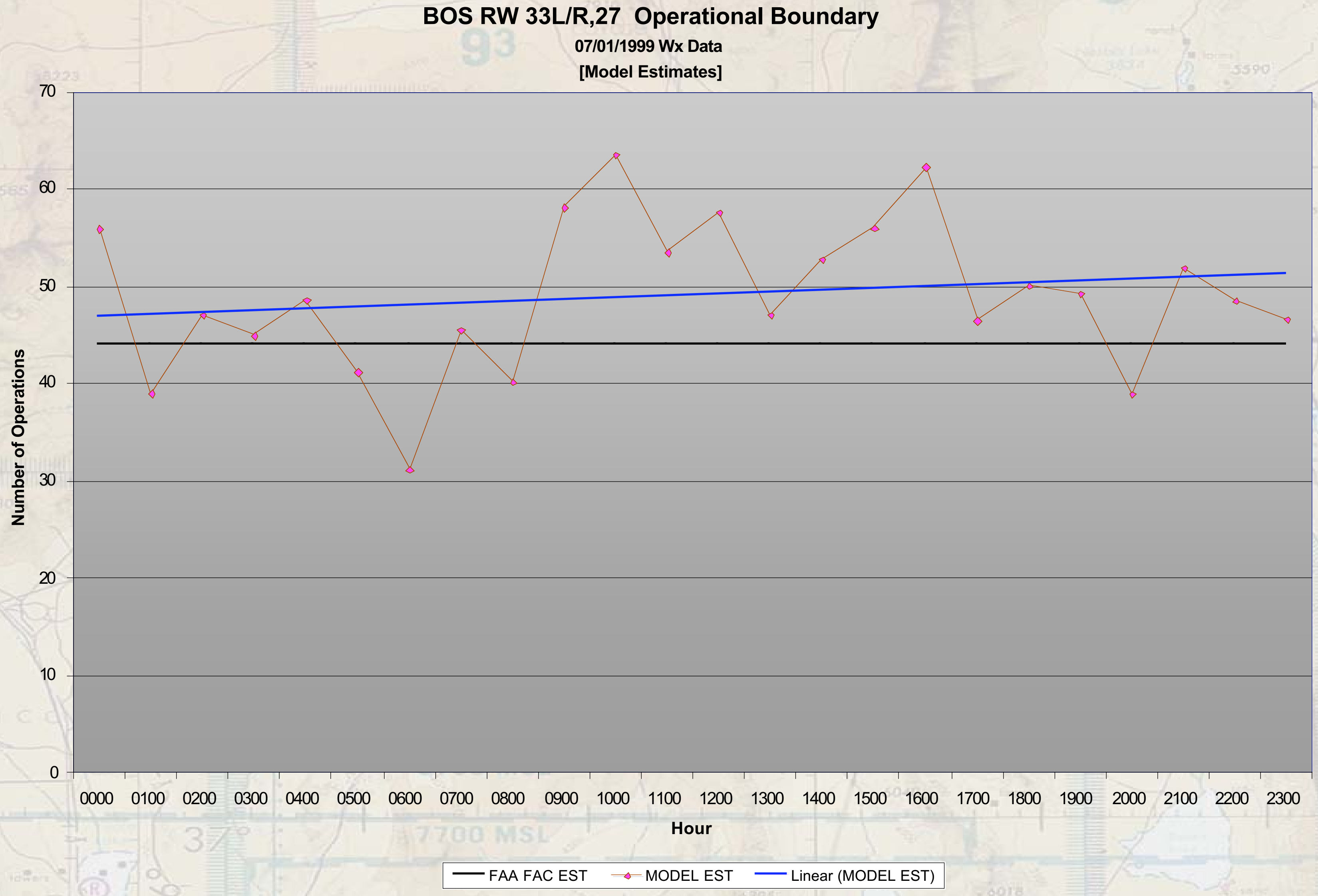
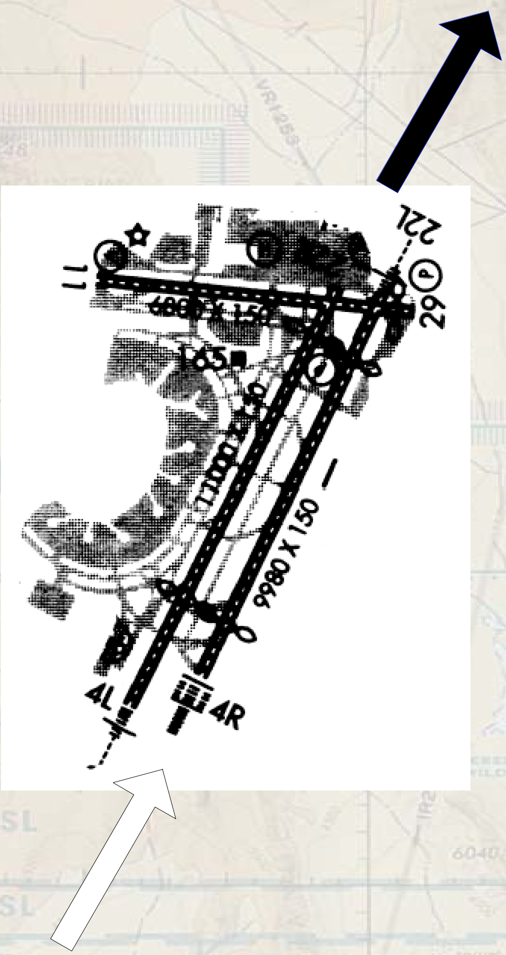


EWR



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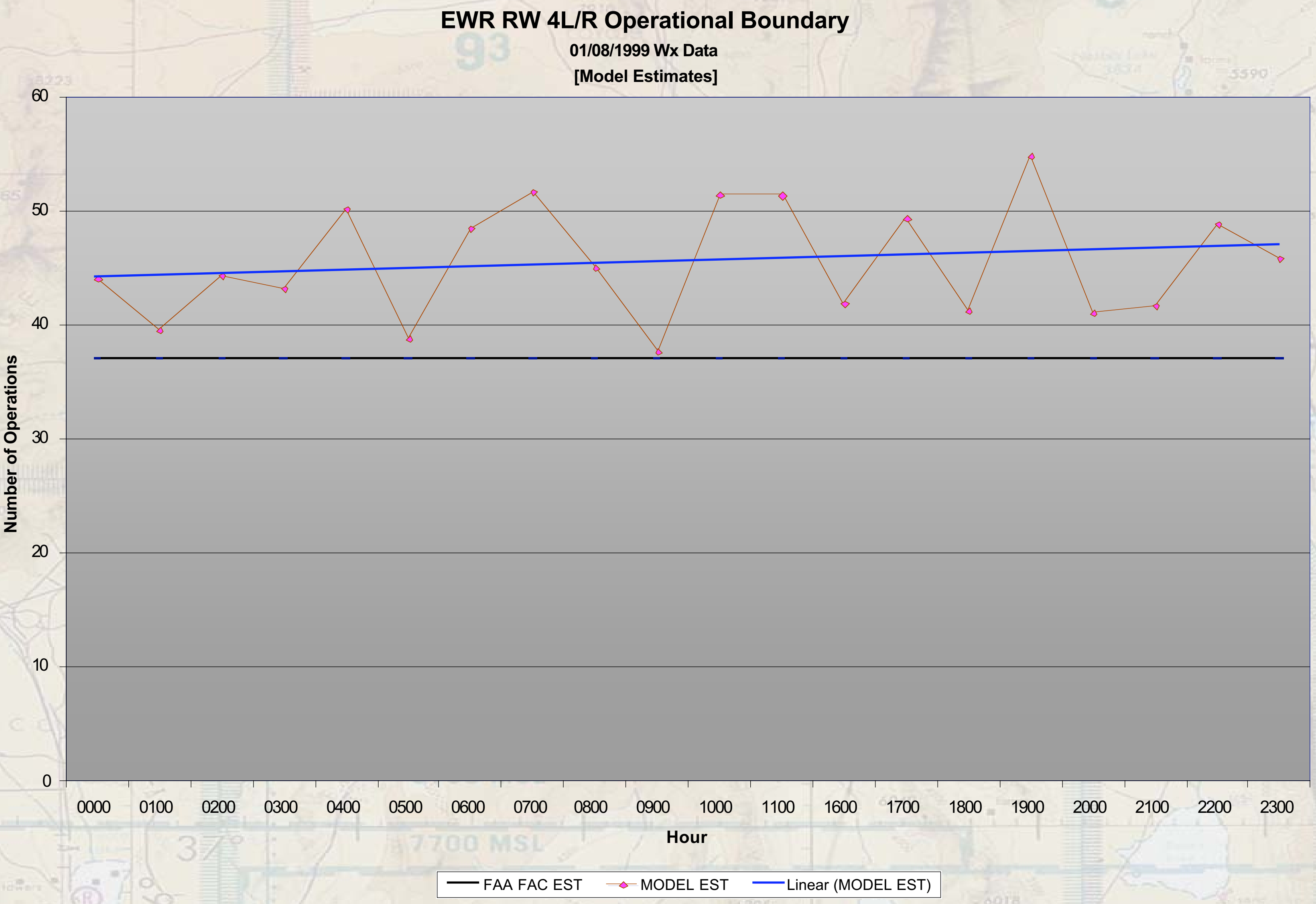

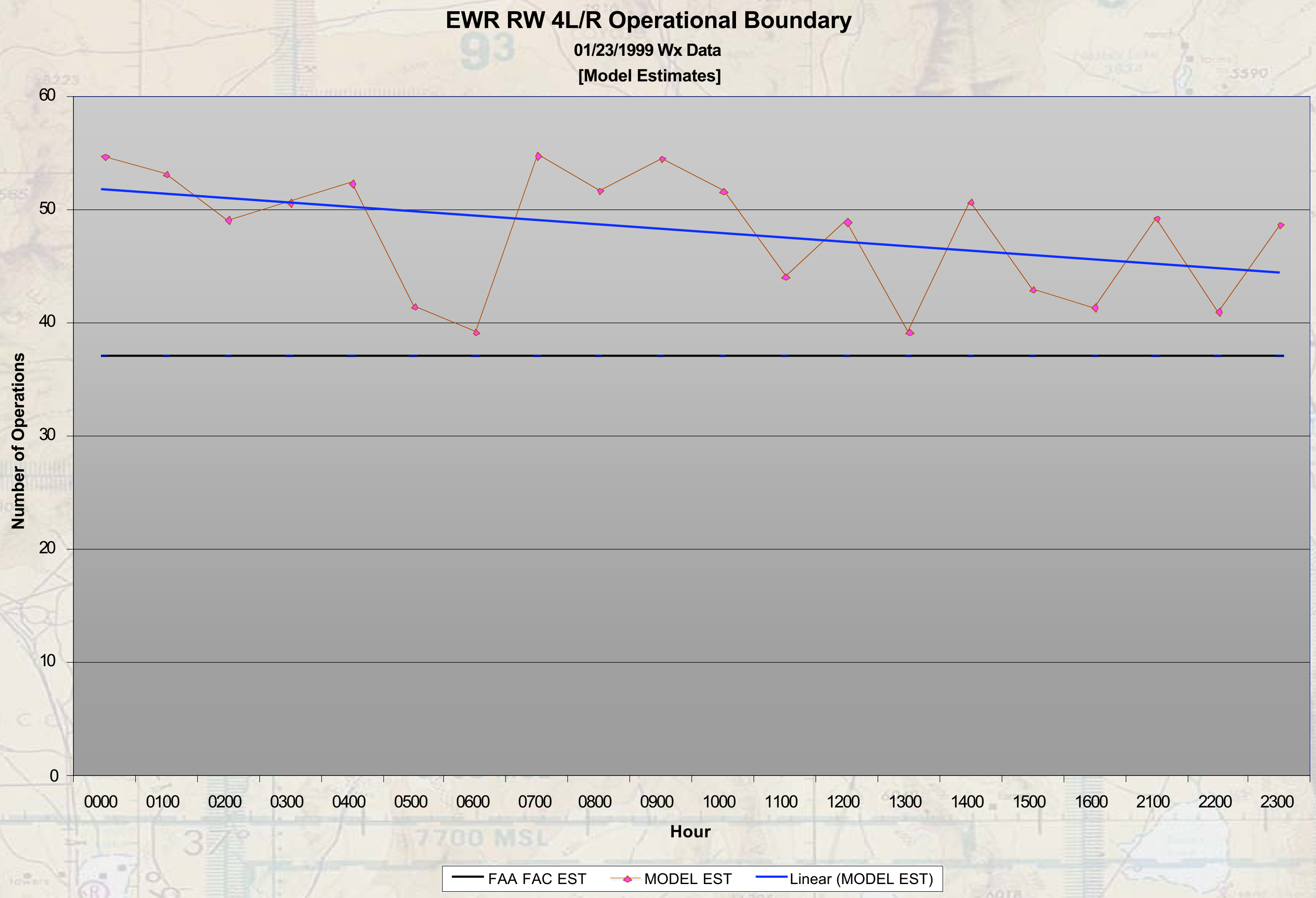
EWR RW 4L/R Operational Boundary
01/23/1999 Wx Data
[Model Estimates]
Number of Operations
0
10
20
30
40
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0000
0100
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Hour
FAA FAC EST
MODEL EST
Linear (MODEL EST)

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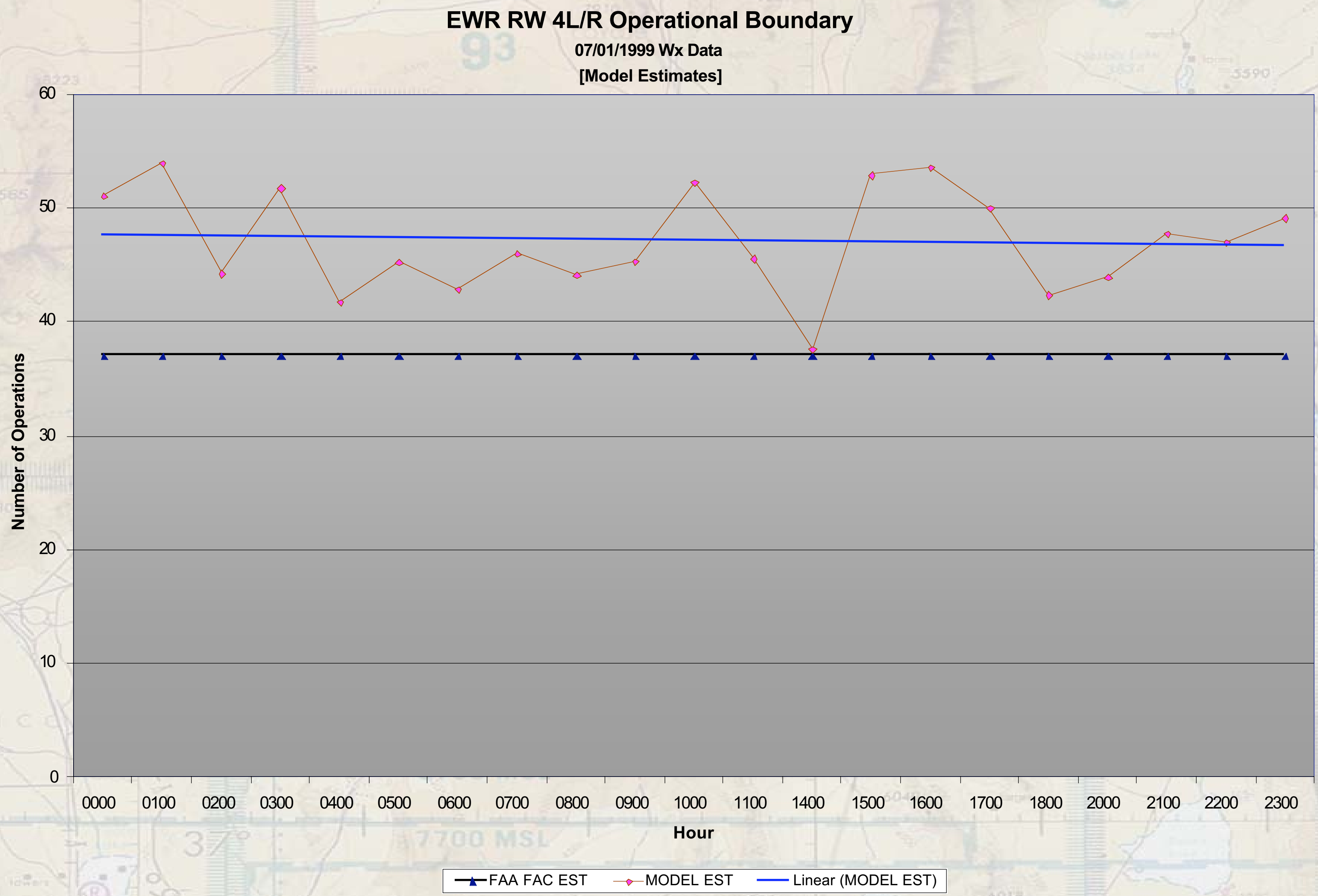

Analysis Synopsis
(To Date)

- Subject WakeVAS concepts show greater promise as a tactical rather than strategic tool.

- The self-evaluation validated the need for a strategic (more than 1 hour, minimum) prediction of system operation, as the lost VMC capacity will often be regained by the prevention of ground delay programs. Future research will quantify the duration and accuracy of these predictions.

- Analysis results have remained consistent with prior research efforts.

Concluding Remarks

- Continue research using updated ETMS dataset.
- Capture TFM procedures and evaluate influences WakeVAS could introduce for higher-fidelity enroute analysis.
- Perform a comparative series of analysis in ACES.